Remote sensing makes widespread contributions to vital signs monitoring

By John Gross

LOGISTICAL DEMANDS REQUIRED to monitor natural resources frequently challenge the networks of parks that have been established for inventory and monitoring. Areas of concern may be large, rugged, remote, or even submerged, and physically collecting data may be expensive, dangerous, and sometimes impossible. Furthermore, ecologically important processes—including fire, windthrow, and vegetation change—can occur on such vast, landscape scales that ground-based monitoring is simply not practical. To address these needs, monitoring networks are rapidly integrating remotely sensed data into monitoring programs and collaborating with partners to develop novel techniques to better use "data from space." In 2003 alone, at least eight networks used remote sensing to aid in managing fires, creating vegetation-fuels maps, and monitoring the effects of invasive plants and changes in land use.

Mitigating the spread of invasive plants depends on up-to-date information about distribution and abundance. Resource managers routinely have used high-resolution, remotely sensed data to identify woody weeds, where structural (rather than spectral) attributes contributed to easy identification. Distinguishing between species of herbaceous plants is usually not possible from remotely sensed data, but researchers from the U.S. Geological Survey (USGS) collaborated with staff in Canyonlands National Park (Utah) to combine spectral signatures and temporal patterns to identify and map the occurrence of cheatgrass (*Bromus tectorum*), a highly invasive, nonnative species. The ability to identify and map cheatgrass will vastly improve the efficiency of monitoring efforts by reducing the area that needs to be examined through ground-based sampling. Remotely sensed data also provide a means to extend routine monitoring, based on satellite imagery, to much larger areas in the extremely rugged and remote parks on the Colorado Plateau.

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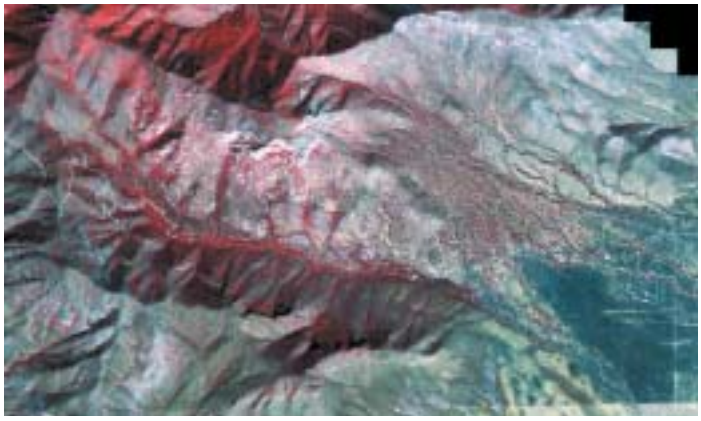
Another important application of remotely sensed data is the evaluation of changes in land use. Scientists have repeatedly identified changing land-use patterns as one of the most important long-term threats to park resources. Five Inventory and Monitoring networks are collaborating with universities and the USGS to develop protocols using remotely sensed data to monitor and evaluate consequences of land-use change in and near more than 50 units of the National Park System. In the Northeast the smaller size of parks and higher intensity of land use justify analyses based on high-resolution satellite data. In other areas where the scales of analysis are broader, lower-resolution satellite imagery (e.g., LandSat, Modis, ASTER) will be an important component of integrated analyses that combine imagery with spatially explicit databases that include information on population size, home density, and other indicators of land use. When integrated, these sources provide a rich picture of the changing landscape in which parks are embedded.

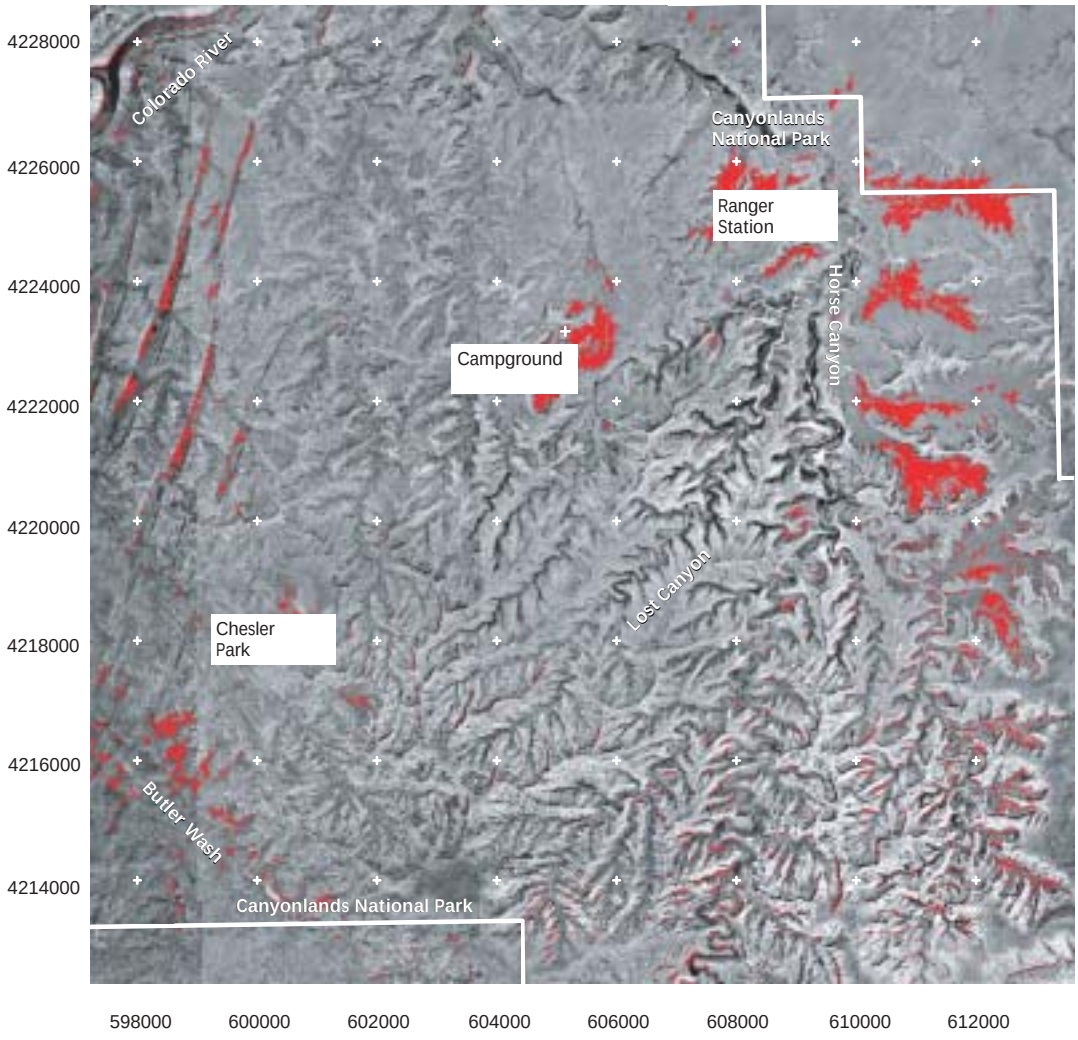


This IKONOS satellite image of Coronado National Memorial, Arizona, reveals variation in plant species distribution and density that results from environmental differences in slope, aspect, soils, and land management practices. The sharp angle near the top and the horizontal line near the bottom of the image reflect much higher grazing pressure from cattle outside the fenced memorial boundary. Many of the roads near the right edge of the image were created by illegal immigration and smuggling. Information from remotely sensed images is valuable for assessing the natural resource impacts of illegal transit through the park from Mexico, fire management planning, vegetation mapping, and evaluating land uses along park boundaries that may affect park resources.

Natural Resource Year in Review—2002 (see page 57) documented a smaller-scale change in land use within parks: the impacts of large numbers of illegal immigrants and smugglers moving through parks on the U.S.-Mexican border. This problem is especially acute in Organ Pipe Cactus National Monument (Arizona), where impacts include trails, off-road vehicle tracks, and construction of temporary shelters. Dangers posed during confrontations with smugglers limit the ability of the National Park Service and its partners to conduct field surveys to identify travel routes and impacts. In collaboration with researchers from the University of Arizona and with support from the NPS Mexican Affairs Office, the Sonoran Desert Network is examining the use of high-resolution IKONOS satellite imagery to detect and map human impacts on desert environments. Field investigators have confirmed accurate identification of paths, temporary shelters, and unauthorized roads on satellite imagery. Comparisons with images from the mid-1990s have clearly revealed a dramatic increase in resource damage over a period when changes in law enforcement led to propagation of travel through remote park locations.

POTENTIAL CHEATGRASS INFESTATIONS IN CANYONLANDS NATIONAL PARK, UTAH

Satellite remote sensing is being used to detect areas potentially infested by invasive cheatgrass (*Bromus tectorum*), shown in red, in Canyonlands National Park, Utah. For this image, researchers compared Landsat 7 Enhanced Thematic Mapper data collected on April 15, 2001, when cheatgrass was green, with those gathered on July 4, when the grass was brown. The vegetation growth cycle of cheatgrass contrasts with that of native vegetation on the Colorado Plateau, which facilitates identification of cheatgrass-infested areas. The background image is derived from digital orthophotos.



In collaboration with the NPS fire program, managers extensively use aerial photographs and satellite imagery to simultaneously map vegetation and collect data on fuel loads (see article on page 37). Furthermore, the fire program uses contemporary aerial photographs and satellite data to map the extent of fires, estimate burn severity, and evaluate recovery rates over short and long periods.

Remotely sensed data are used throughout the National Park System for inventory and monitoring applications to address key information needs in natural resource management. This information will be increasingly important to monitoring programs as the quality of data improves and the price to acquire them decreases. ■

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